

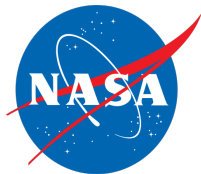
EBAF update: surface fluxes

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NASA Langley Research Center

CERES Science team meeting

October 12-14, 2021

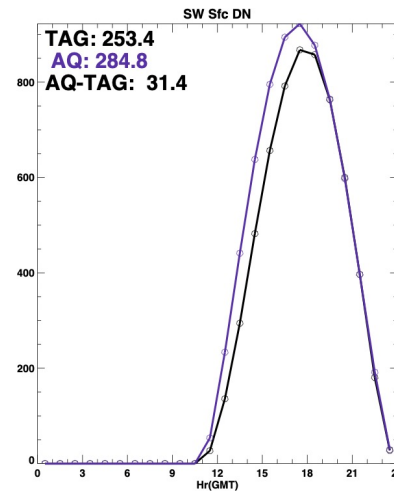
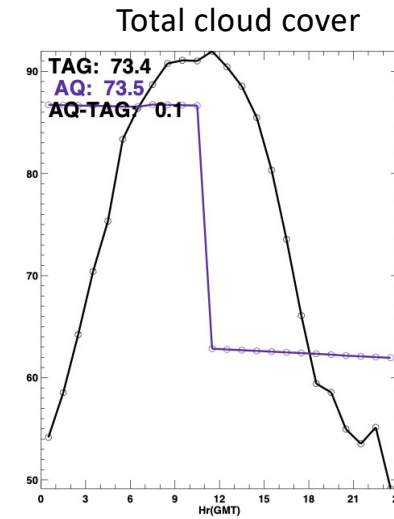


EBAF (surface) Edition 4.2

- EBAF is a climate data product and producing surface fluxes with no GEO artifacts are important
 - GEO artifacts: temporal discontinuities caused by different GEOs used over the course of the time series and spatial discontinuities among GEOs used at the same time.
 - Climatology adjustment allows us to use Terra only, Terra+Aqua, and NOAA-20 only.
 - SYN1deg will be processed with clouds derived from Terra and Aqua only (SYN1deg-noGEO)
 - No cloud reprocessing, i.e. Terra and Aqua cloud properties will be derived using GEOS-5.4.1
 - MERRA-2 temperature and humidity profiles will be used throughout the record
 - Surface longwave fluxes are directly affected by temperature and humidity discontinuities in GEOS-5.4.1 while geo artifacts are much larger than cloud property discontinuities caused by GEOS-5.4.1.
- Emphasis of Edition 4.1 SYN1deg (Terra+Aqua+GEOs) is surface irradiances with high temporal resolution and diurnal cycle.

Terra+Aqua cloud properties

- Daytime and nighttime cloud properties (fraction, optical thickness, phase, top and base pressures) are interpolated separately for each grid box.
- Monthly mean cloud properties before the first observation in the month and after the last observation in the month



Downward
shortwave
flux

Pre-process analysis

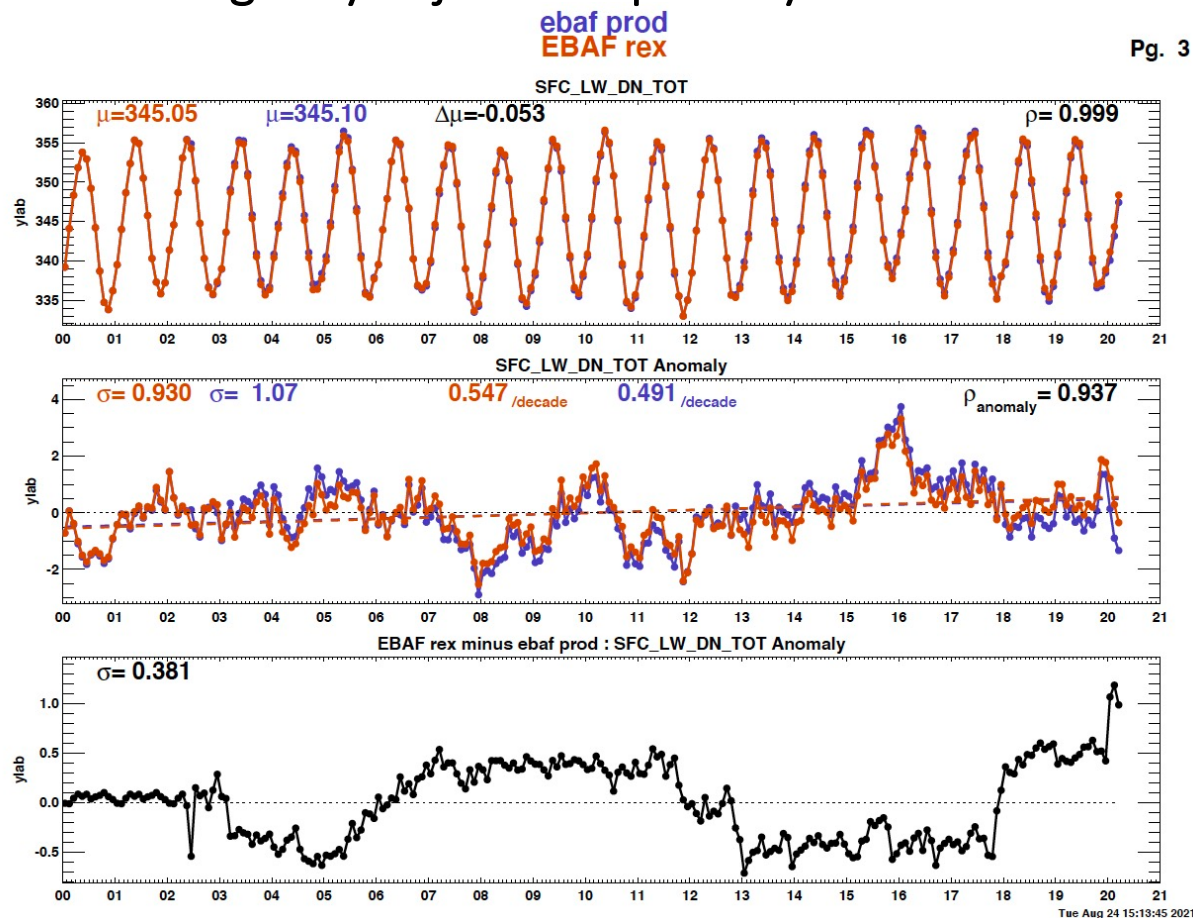
- GEO artifacts are taken out but does Terra+Aqua no GEO product provide realistic **regional** trends?
- Does Terra+Aqua with no GEO provide the correct climatology (versus Terra+Aqua+GEOs)?
 - Because we do not have Terra+Aqua surface fluxes for the entire record, we will answer this question when we have Terra+ Aqua surface fluxes
- We use climatologically adjusted Aqua SYN1deg (fluxes are computed with Aqua clouds and climatology is adjusted to that of Terra+Aqua+GEOs) processed with GEOS-5.4.1 in this presentation to demonstrate the SYN1deg noGEO product.

Global downward surface longwave flux comparison: Edition 4.1 EBAF (Terra+Aqua+Geo) vs. climatologically adjusted Aqua only

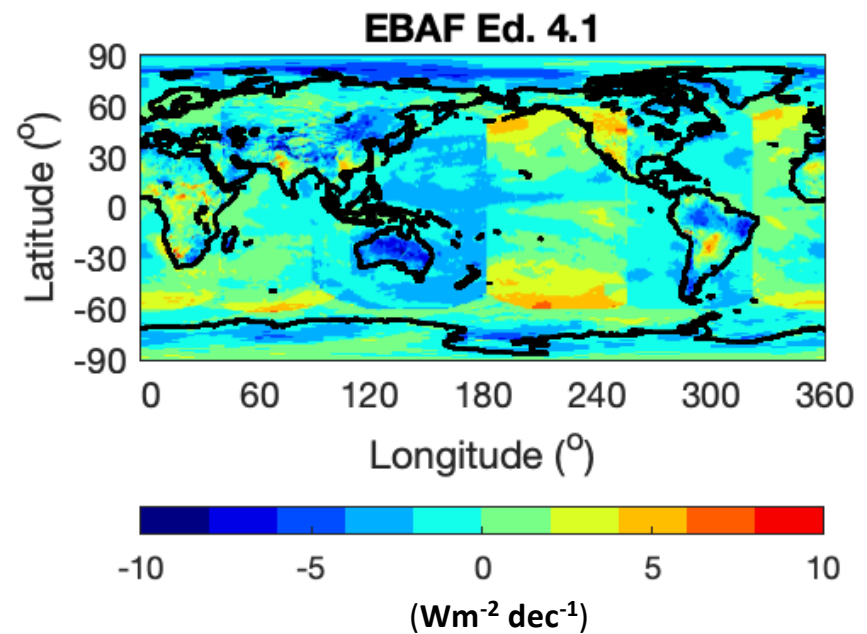
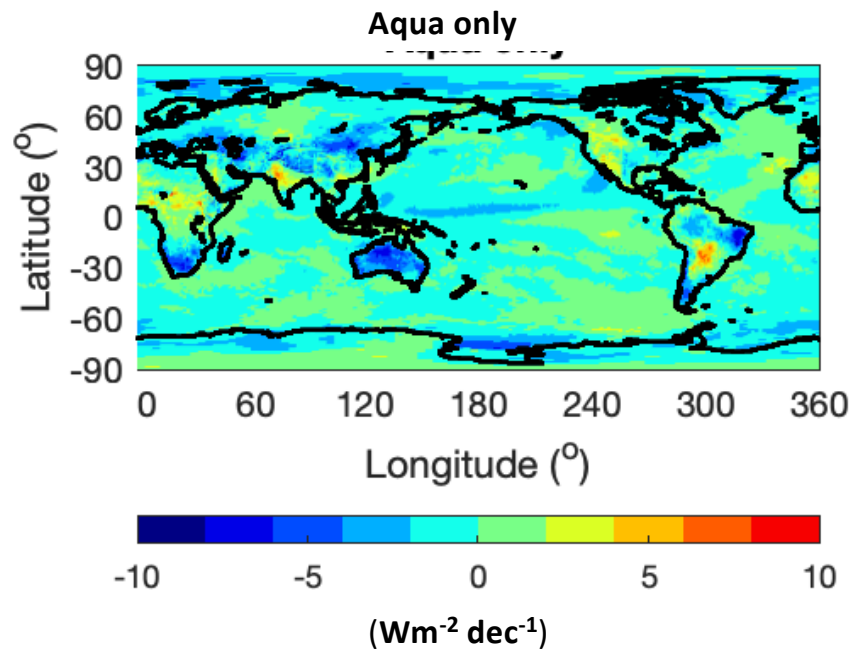
Pg. 3

Global monthly anomalies of downward longwave irradiance

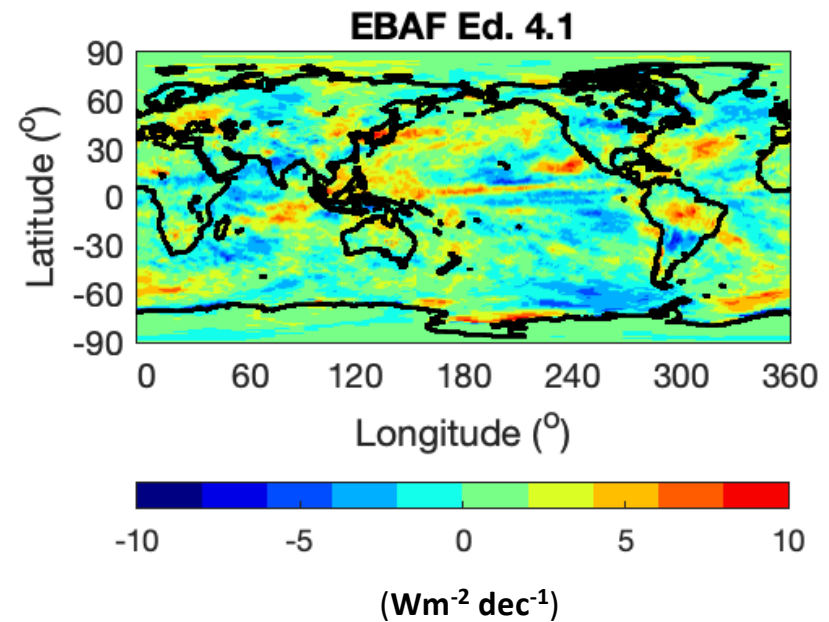
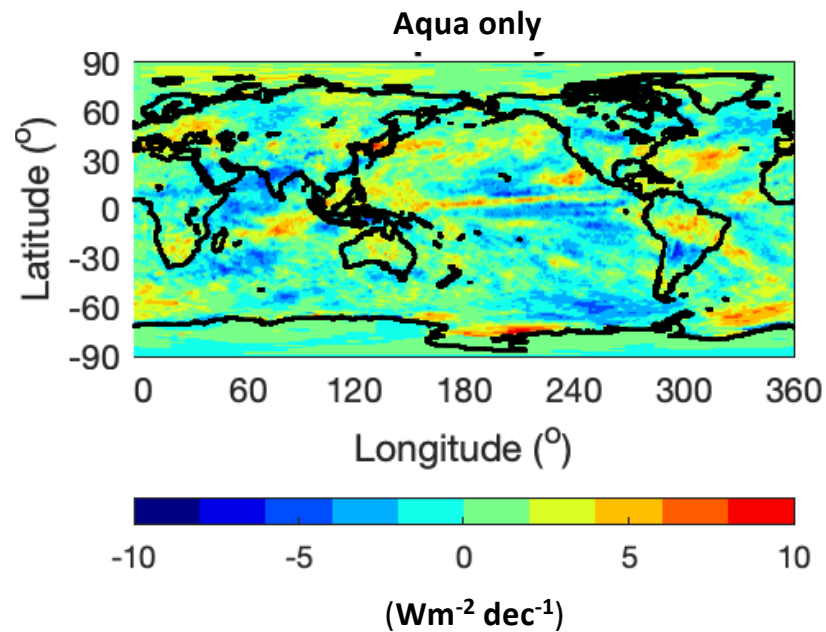
GEO artifacts introduce $\sim 1\text{Wm}^{-2}$, which is equivalent to $\sim 1\sigma$



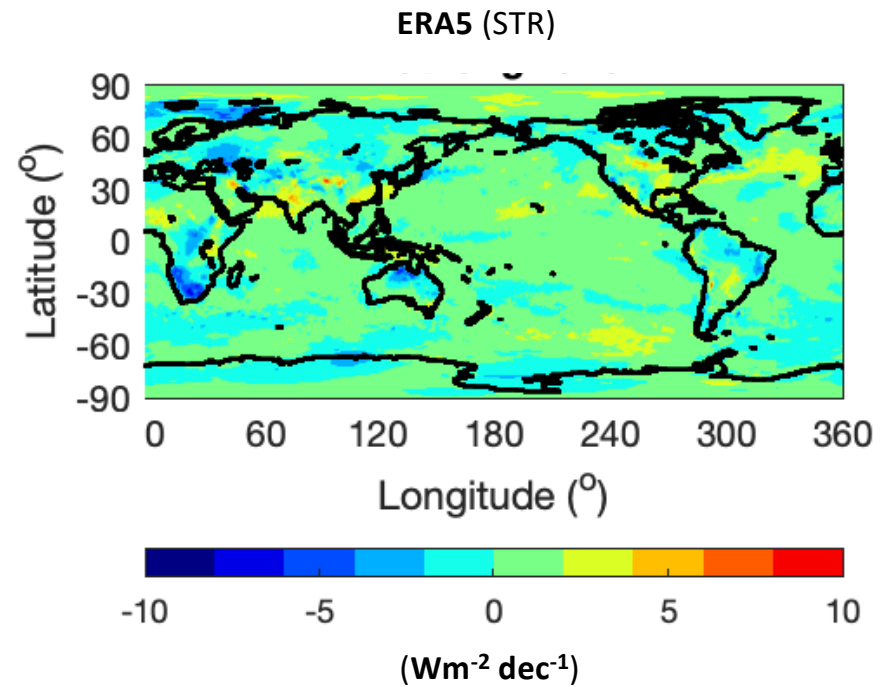
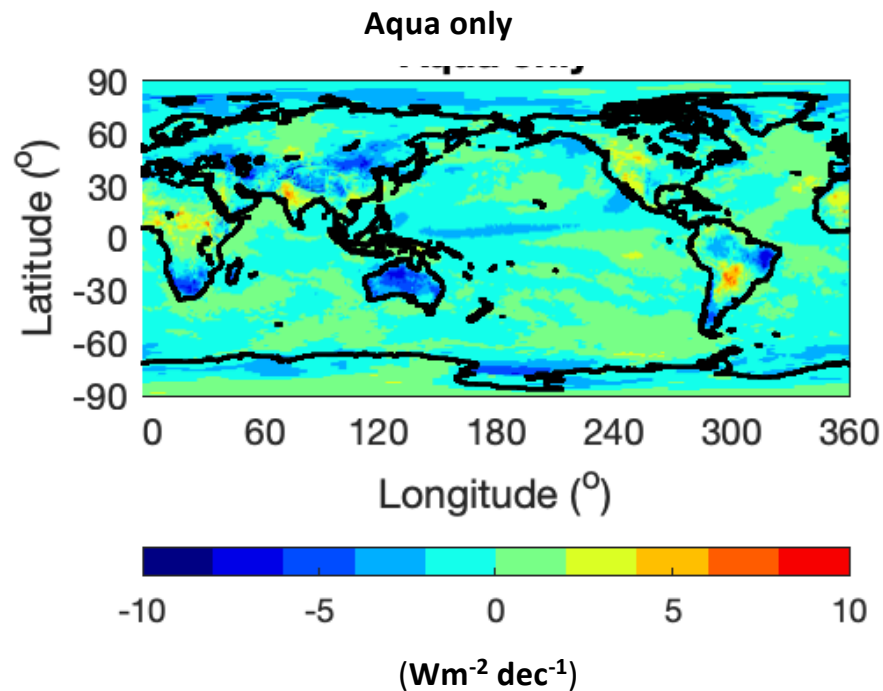
Surface net longwave irradiance trend ($\text{Wm}^{-2} \text{dec}^{-1}$)
200208 to 202002, positive downward



Surface net shortwave irradiance trend ($\text{Wm}^{-2} \text{dec}^{-1}$)
200208 to 202002, positive downward

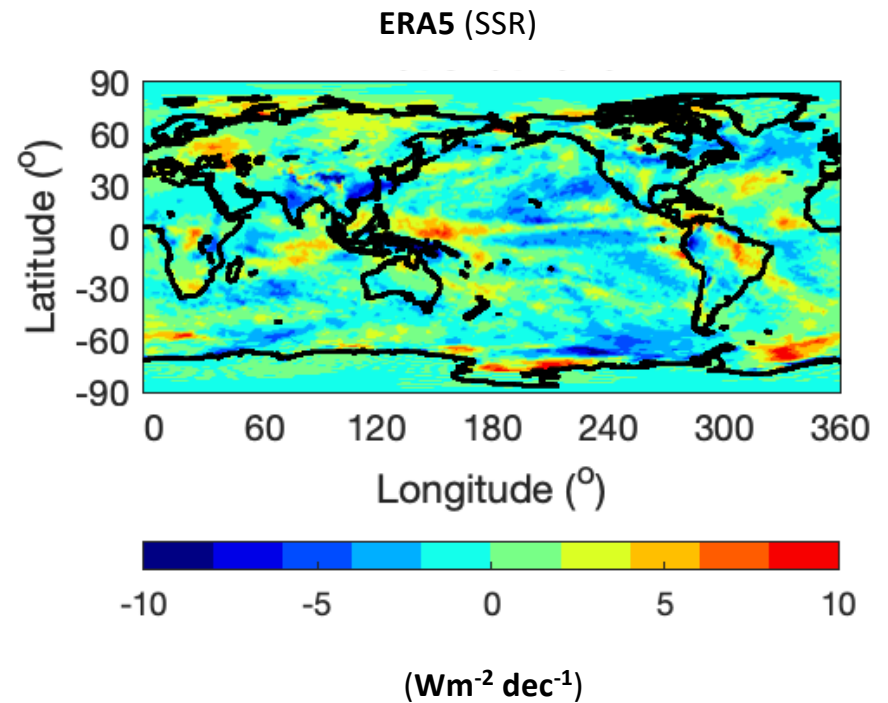
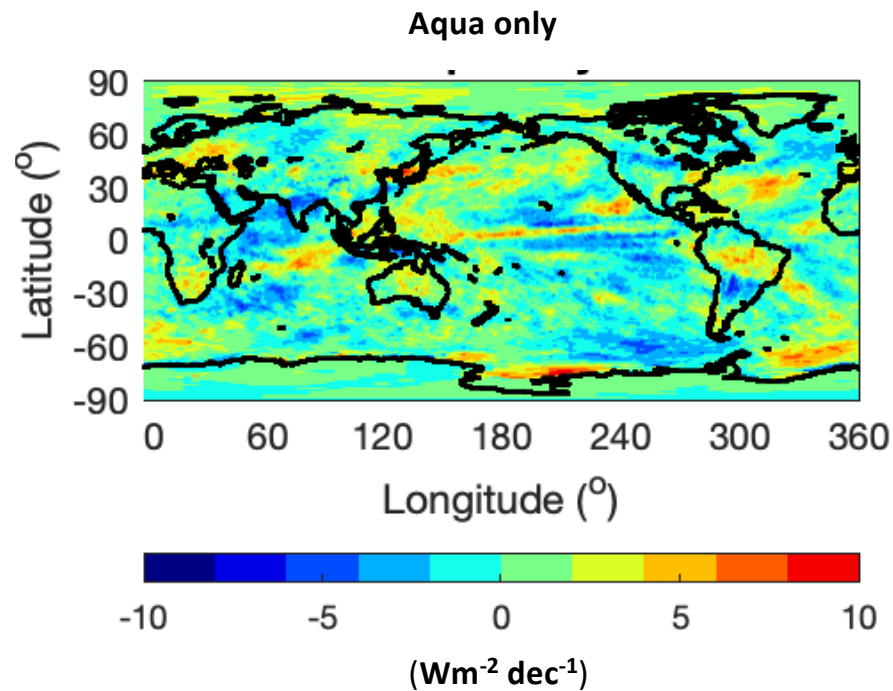


Net longwave surface irradiance trend ($\text{Wm}^{-2} \text{dec}^{-1}$)
200208 to 202002, positive downward



GEOS-5.4.1 was used for Aqua only

Net shortwave surface irradiance trend ($\text{Wm}^{-2} \text{dec}^{-1}$)
200208 to 202002, positive downward

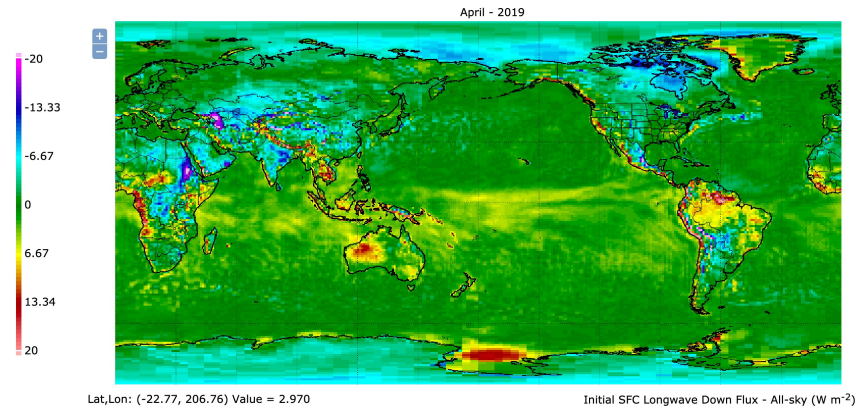


Sensitivity study using MERRA-2

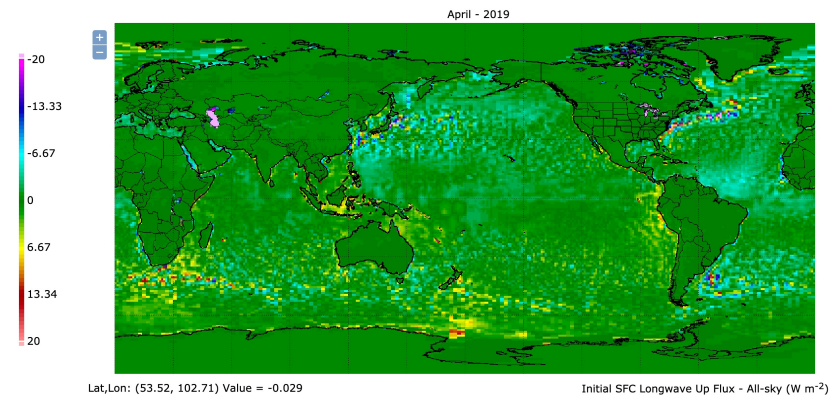
- To understand regional flux differences from Edition 4.1
 - Edition 4.1 surface fluxes and clouds were derived using GEOS-5.4.1
- Surface fluxes are computed with MERRA-2 using clouds (Terra, Aqua, and GEOS) derived with GEOS-5.4.1 (SYN1deg)
 - fluxes are diurnally averaged
- Surface fluxes are computed with MERRA-2 using clouds (Aqua) derived with GEOS-5.4.1 (CRS)
 - Instantaneous fluxes

Computed fluxes with MERRA-2 minus computed fluxes with GEOS-5.4.1
 GEOS-5.4.1 Terra+Aqua+GEO clouds for both

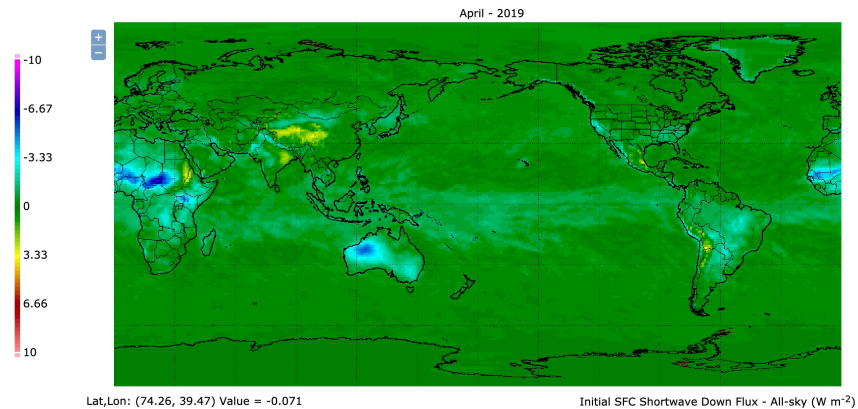
Downward longwave



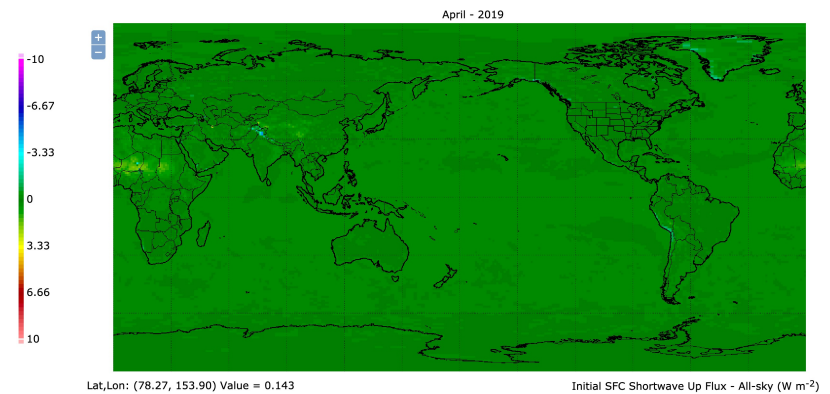
Upward longwave



Downward shortwave

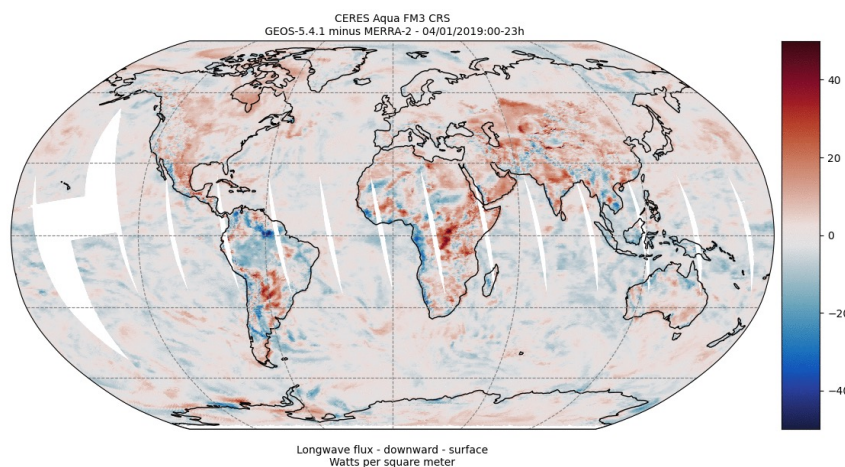


Upward shortwave

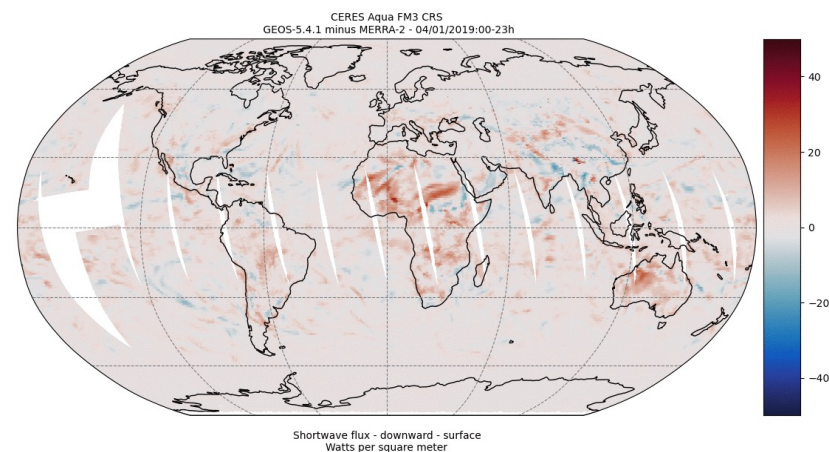


Instantaneous flux difference
Computed flux with MERRA-2 minus computed flux with GEOS-5.4.1
GEOS-5.4.1 Aqua clouds for both

Downward longwave



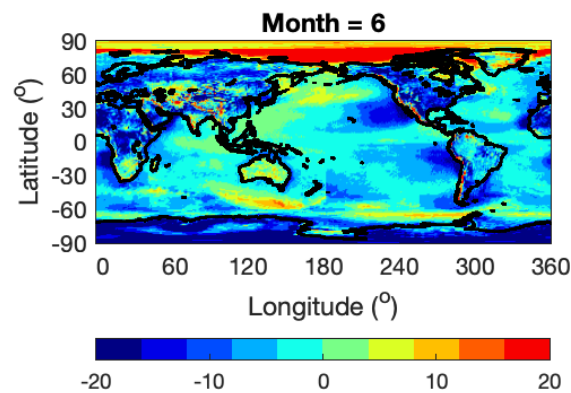
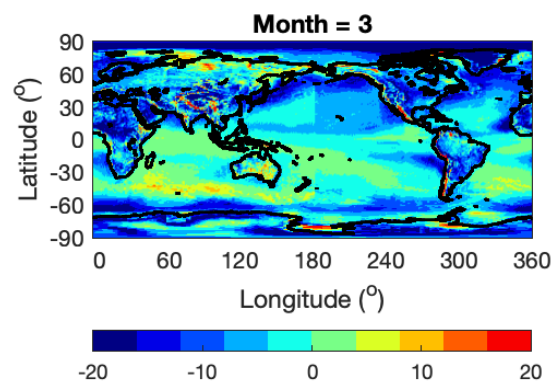
Downward Shortwave



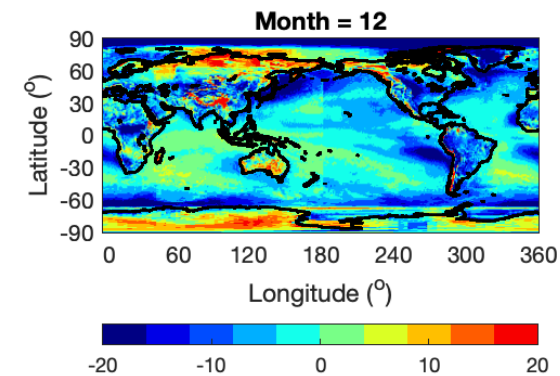
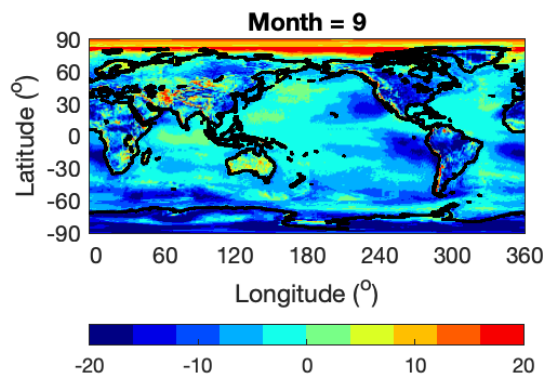
Aqua only, Spatial difference pattern is similar to SYN1deg (i.e. Terra+Aqua+ GEOs) differences

The use of Terra+Aqua+GEOs for surface
irradiance climatology (preliminary results)

Surface net longwave flux 20208-201807 climatology differences in Wm^{-2}
ERA5 – Terra+Aqua+GEOs



GEO artifacts affect climatology.



Summary

- Aqua only anomaly time series provides regional trends comparable to those derived from ERA5
- Geo artifacts appear in Terra+Aqua+Geo surface net longwave climatology
 - Need further investigation to evaluate Terra+Aqua surface irradiance climatology
- Surface fluxes computed with Terra only, Terra+Aqua, and NOAA20 only clouds (i.e. no GEOs) using GEOS-5.4.1 and with MERRA-2 temperature and humidity profiles eliminate the effect of GEO artifacts and GEOS-5.4.1 temperature and humidity discontinuities.

Backups

A plan for Edition 4.2 EBAF

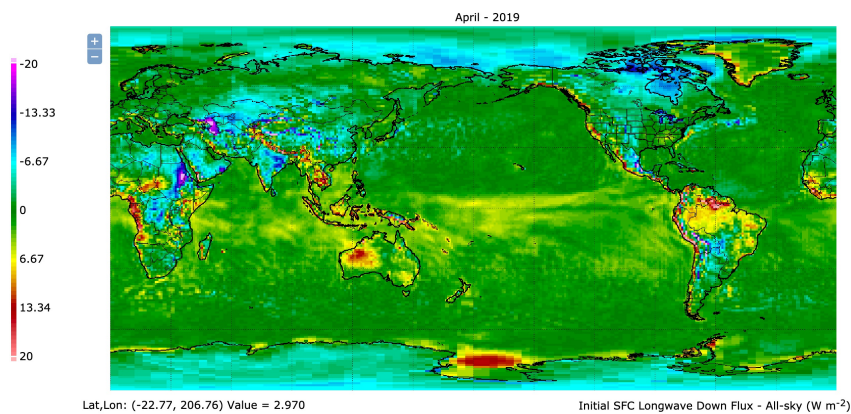
- Input: SYN1deg-noGEO (run at DAAC)
 - Production begins early 2022
- Use MERRA-2
 - MERRA-2 MOA (code delivery)
- Terra-only from 03/2000 through 06/2002 (+ 5 to 10 years for climatology)
 - Terra only MATCH
 - Clouds derived from Terra only (TSI) (needs off-line test)
- Terra+Aqua from 07/2002 through 06/2022
 - Terra + Aqua MATCH
 - Clouds derived from Terra+Aqua (TSI)
- NOAA20-only from 07/2022 through 06/2023
 - VIIRS MATCH (NPP or NOAA-20)
 - Clouds derived from NOAA-20 VIIRS

Sensitivity study results: MERRA-2 vs. GEOS-5.4.1

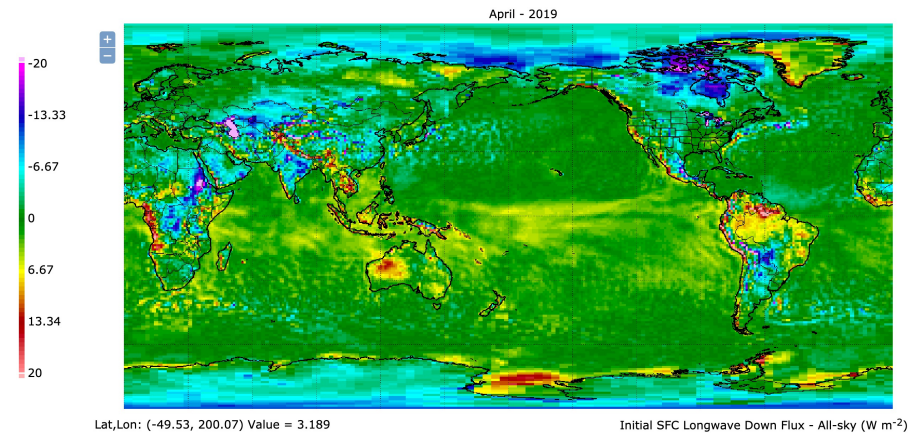
- Understand TOA and surface flux sensitivity to reanalysis data product used for the flux computations.
 - SARB only: Use clouds derived with GEOS-5.4.1 but compute surface fluxes using MERRA-2
 - Cloud+SARB: Use MERRA-2 for both deriving clouds and computing surface fluxes.
- Produce SYN1deg, SSF, and CRS for April 2019
 - SARB only: SYN1deg (Terra+Aqua+GEO) and CRS
 - Cloud+SARB: SSF, CRS, and SYN1deg
- SARB only (MERRA-2) – Edition 4.1 SYN (GEOS-5.4.1)
 - Regional surface flux differences are caused by temperature and humidity differences
- Cloud+SARB (MERRA-2) – SARB only (MERRA-2)
 - Regional surface flux differences are caused by cloud differences
 - Analogous to the bias of the Edition 4.2 EBAF case

Downward longwave sensitivity

SARB only (MERRA-2) - Ed4.1 SYN1deg (GEOS-5.4.1)



Cloud+SARB (MERRA-2) - Ed4.1 SYN1deg (GEOS-5.4.1)

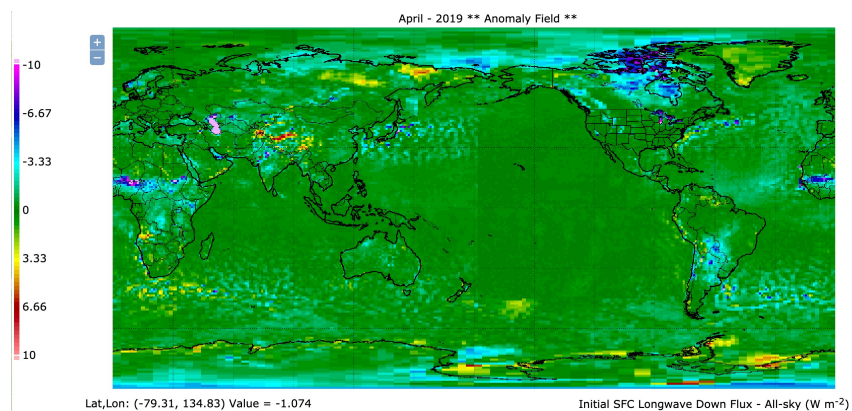


Global mean (Std. dev)	SARB only – Ed4.1 SYN	(SARB+Cloud) – Ed4.1 SYN	SARB only – (SARB+Cloud)
LW down (Wm^{-2})	0.803 (3.62)	0.489 (4.15)	0.315 (1.13)
LW up (Wm^{-2})	-0.120 (2.63)	-0.086 (3.71)	-0.034 (2.51)
SW down (Wm^{-2})	-0.374 (0.66)	-0.188 (0.97)	-0.186 (0.87)
SW up (Wm^{-2})	0.011 (0.17)	-0.029 (1.37)	0.040 (1.35)

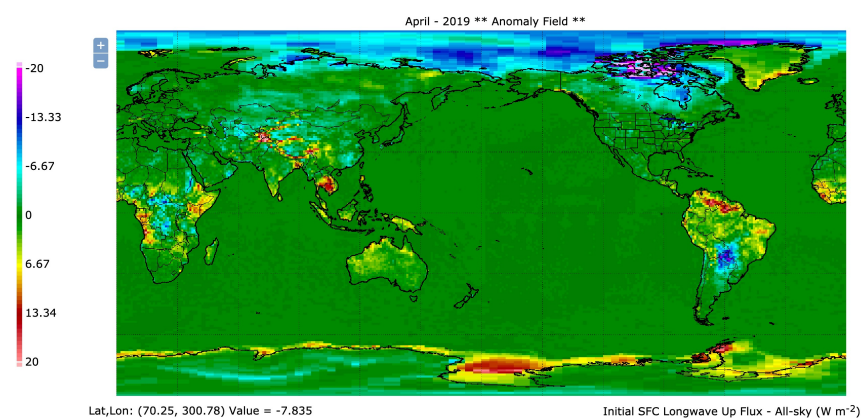
Generally, more differences in inputs lead to larger surface irradiance differences

Difference due to inconsistent reanalysis between cloud and SARB
 SYN1deg (Terra+Aqua+GEOs)
 SARB+Cloud (MERRA-2)- SARB only (MERRA-2) surface irradiance difference

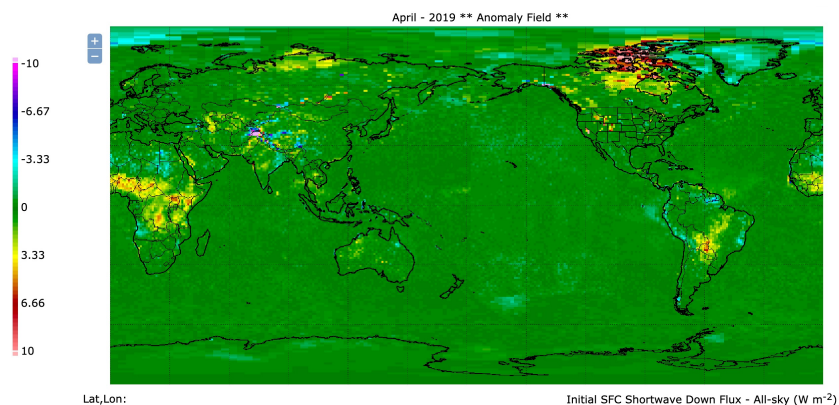
Downward longwave



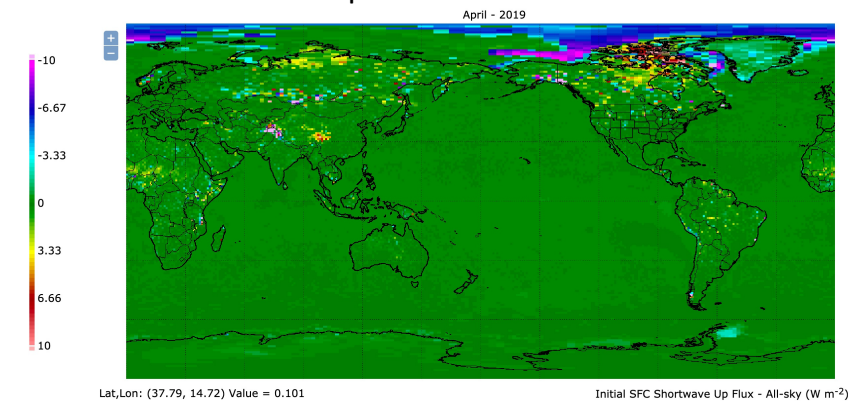
Upward longwave



Downward shortwave

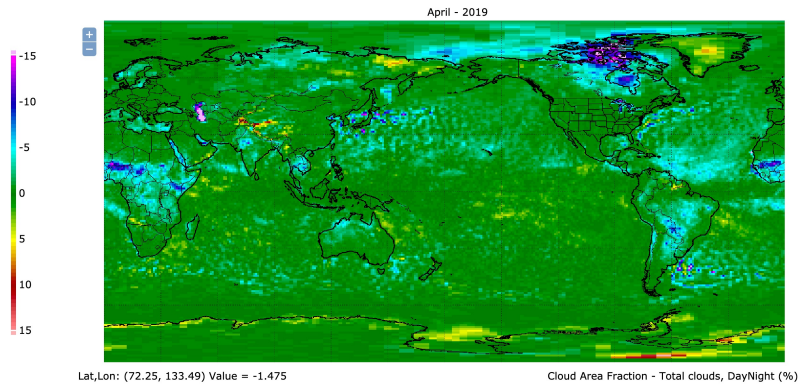


Upward shortwave

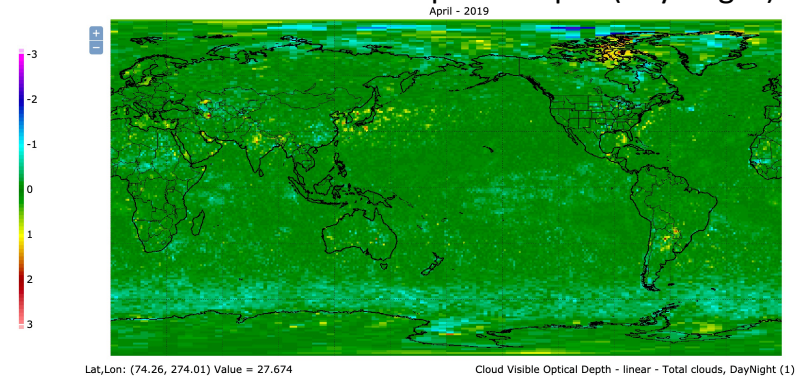


Cloud property differences: MERRA-2 – GEOS-5.4.1

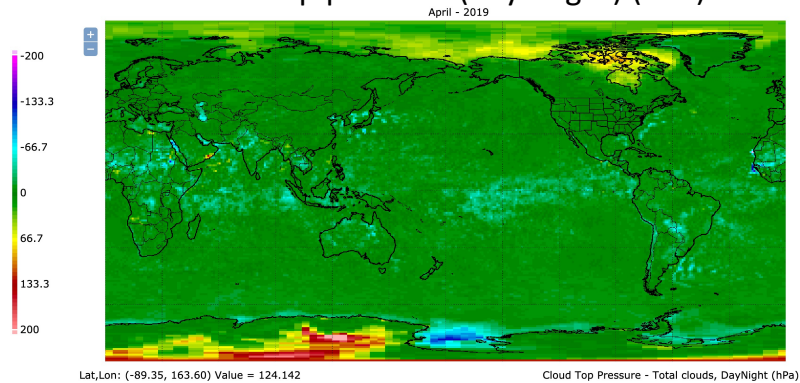
Cloud cover (day+night) (%)



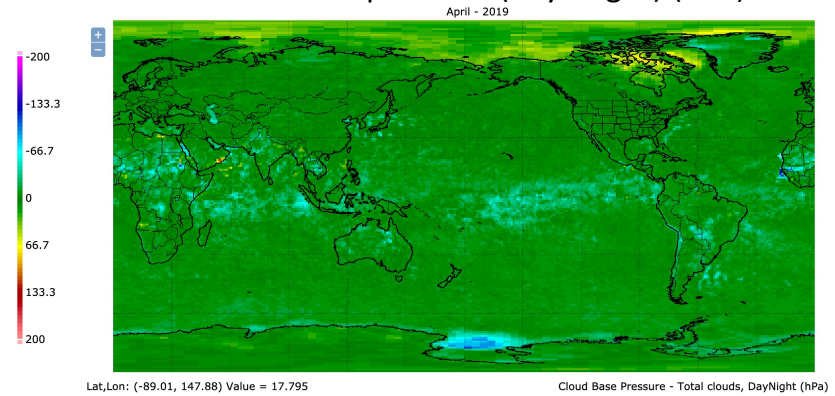
Visible optical depth (day+night)



Cloud top pressure (day+night) (hPa)



Cloud base pressure (day+night) (hPa)



Surface net shortwave flux 20208-201807 climatology differences in Wm^{-2}
ERA5 – Terra+Aqua+GEOs

